# The Impact of Parents' Perceptions of the Food Quality Within Their Neighborhood and Most Frequented Food Stores and the Distance to Food Stores on Children's Diet Quality

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A thesis
submitted in partial fulfillment of
the requirements for the degree of

Master of Public Health

University of Washington
2013

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Program Authorized to offer Degree:
School of Public Health- Health Services

University of Washington

## Abstract

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**Background:** Childhood obesity has reached epidemic proportions in the United States, which could signal an unprecedented shift in lifespan, with the current generation living a short life than their parents. Although there are a variety of contributing factors, some of the largest gains in childhood obesity reduction could come from examining the relationship between the neighborhood food environment and children's diet quality (DQ). While many studies have investigated the influence of distance to supermarkets on adults' DQ, few have examined the effects on young children. Further, studies have rarely considered parents' perceptions of local food quality as a predictor of children's DQ, nor have studies used the parents' frequented food store (FFS) as the measure of exposure. Finally, there remains a need to assess if parents travel farther for food shopping when their perceptions of neighborhood food quality differ from their perceptions of food quality at their FFS, because this additional travel burden may be prohibitive to healthy food procurement.

**Methods:** Participants were 686 parent-child pairs from the Neighborhood Impact on Kids (NIK) Study. Parents' perceptions of neighborhood and FFS quality were assessed via survey. Children's DQ was measured as adherence to the Dietary Approaches to Stop Hypertension (DASH) eating plan's overall and fruit and vegetable (F&V) recommendations through three, random 24-hour dietary recalls. FFSs were identified via survey and street network distances from home to the store were calculated via GIS. Linear regression analyses assessed the associations between parents' perceptions and child DQ as well as distance to the FFS and child DQ. A paired t-test determined if parents held discordant views about food quality between their neighborhood and FFS, and Spearman rank correlation coefficients assessed the association between discordance and food shopping distance.

**Results:** No statistically significant associations were found between parents' perceptions of FFS quality and children's overall DASH score in the adjusted analyses; however, the F&V component DASH score remained significant (p=.05). The adjusted models indicated that increasing distance to the parents' FFS improved children's overall and F&V component DASH scores. Parents' views of food quality within their neighborhood versus FFS differed, with FFSs

receiving more positive assessments. Discordant views were weakly and significantly associated with distance to the FFS ($r=-0.1$, $p=.01$).

**Conclusions:** Parents' perceptions of the food quality at their FFS are only weakly associated with children's DQ. This may be due to the fact that many factors impact food choice decision-making. The finding that children's DQ improved with increasing distance to the FFS suggested that parents valued healthfulness and were willing to travel farther to procure healthy, affordable food. Additionally, restricting the focus to just the relationship between the home and the FFS may have obscured the true nature of the food environment-diet quality relationship, and future studies should include other common destinations in one's daily activity space (e.g. work or school).

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## Introduction

Today's generation could be the first in our nation's history to live a shorter life than their parents and this is due in large part to the obesity epidemic and its complications.[1, 2] Within one generation, or 30 years, the obesity rate among children in the United States (U.S.) has more than tripled: in 1980 about 5 percent of youth between the ages of six and 19 were classified as obese, but by 2010 over 17 percent were obese.[3-5] Clearly, this is a dramatic shift in a short period of time and it is alarming because these children are very likely to remain obese into adulthood, signaling a lifetime of health complications.[3, 6-9] While health consequences are of primary concern, there are substantial costs to society as a whole from an economic perspective. The Robert Wood Johnson Foundation estimates that the costs of obesity in the United States range from $147 to $210 billion annually.[10]

The short and long-term consequences of obesity in terms of physical and mental health are severe. Obesity increases the risk of asthma, heart disease, stroke, cancer, metabolic syndrome, type II diabetes, osteoarthritis, low self-esteem, and depression.[11-13] The Foresight Obesity Map shed light on the complex system of determinants that are responsible for this fast shift in obesity rates.[14, 15] The map moves thinking beyond the level of the individual and forces researchers and policymakers to adopt a systems-perspective in order to consider the interconnected social and environmental influences. The map also lends support to the idea that our modern lifestyle is in part responsible for this change, because we now live in *obesogenic* environments that contribute to a pattern of inactivity and over-eating, leading Americans to become heavier.[16, 17]

Although several determinants related to childhood obesity could be studied, some of the largest gains in obesity reduction could come from examining the relationship between the neighborhood food environment and children's diet quality, because the neighborhood food

environment has population-level impacts.[18] Understanding this relationship is particularly important among the youth population because eating patterns established in childhood carry into adulthood.[19-21] Thus, childhood can be seen as a critical window for establishing lifelong healthy eating habits, and it is important to understand what factors facilitate these behaviors. Although several studies have demonstrated an association between the neighborhood food environment, diet quality, and obesity for adolescent[22-27] and adult populations,[26, 28-30] the findings have been inconsistent, which demands more research to better understand these relationships. Moreover, the impacts of these relationships on younger children have been minimally explored.

Most studies have operationalized the neighborhood food environment in terms of the ease of accessing healthy food using the distance to the closest supermarket or the density of supermarkets within a defined distance of one's home.[25, 28, 31-36] This practice may be due to knowledge about the distance decay phenomenon, which states that the degree of interaction or influence between two locations (e.g. home and a food store) declines, usually exponentially, as the distance between them increases.[37] For example, a recent study on the nutritional behavior of Los Angeles adults demonstrated that a distance decay model for supermarket accessibility could explain the variation in adults' fruit and vegetable (F&V) consumption.[38] Essentially, living closer to a supermarket, increased the chances that an adult would consume four or more servings of F&V per day.[38] Additional observational studies have demonstrated that living closer to a supermarket is associated with improved diet quality among adults and adolescents, after controlling for race, gender, and measures of socioeconomic status (e.g. income and/or education),[32, 34, 39, 40] but the impacts on obesity have been mixed.[41-43] In contrast, Boone-Heinonen et al. (2011) [44] found no evidence of a supportive relationship between supermarket proximity on the overall diet quality and F&V consumption of young adults. Their null result

may be because their metric for proximity (the number of grocery stores per 10,000 population or supermarkets per 100,000 population within set Euclidean distances of participants homes,) was not an accurate reflection of their sample's access to the health promoting food resources.

Few studies have examined how supermarket distances impact children, and the results have been mixed. The influence of distance may be different for children compared to adults because parents might attach different values to food quality when it can impact the growth and development of their child. A recent study on nine to ten year old children in the United Kingdom demonstrated that the relationship between the neighborhood food environment and youth diet quality is complex because F&V consumption decreased with decreasing distance to supermarkets, but increased with increasing density of supermarkets.[45] Similarly, Timperio and colleagues (2008) found that the likelihood of children under the age of 12 meeting their daily F&V recommendations increased with increasing distance from home to a supermarket.[33] With evidence remaining mixed on the value of distance to food stores as a predictor of diet quality among children, this element of the food environment-diet quality relationship requires further exploration.

Measuring healthy food access based on the distance to the closest supermarket relies on the assumption that people use the food resources that are the most proximate, but this is not always accurate.[46, 47] Some studies have demonstrated that adults will travel farther to reach healthy food if their neighborhood resources are unfavorable,[46, 47] especially if they are parents of young children.[47] Consequently, knowing the distance parents travel from home to their most frequently used food stores may be a more accurate reflection of the time and travel costs associated with food shopping and diet quality, than simply using the closest store.

While important, distance measures alone do not tell the full story of neighborhood food quality. As a result, some studies have employed subjective measurements of neighborhood food quality in order to incorporate the residents' evaluations of their access to healthy food.[32, 40, 48-52] Research on fast food and fruit and vegetable consumption among women from different socioeconomic strata, revealed that perceptions of high quality produce within their neighborhood explained the variations in their F&V consumption.[48] Similarly, Zenk and colleagues (2005) found that women's positive perceptions of produce quality where they shopped, were positively associated with F&V consumption, independent of socioeconomic status.[52] Together, these studies suggest that perceptions of neighborhood food quality may play an important role in determining diet quality. Still, few studies have examined if parents' perceptions about the quality of food in their neighborhood also impacts their child's diet quality. A study of nine to ten year olds in Canada is suggestive of such a relationship, but more evidence is needed to support this idea. The study showed that children of parents with positive perceptions about healthy food access within their neighborhood, had higher diet quality index scores than the children of parents with negative perceptions.[53]

Finally, knowing how parents' perceptions of food quality within their neighborhood compare with their perceptions at their frequented stores may be another important measure of the neighborhood food environment-diet quality relationship. Discordant views would suggest that parents do not shop within their neighborhood, which could be an indication of increased time and financial burdens due to the greater travel required to obtain healthy food. If children are eating a healthy diet, their parents may need to shop more frequently for fresh produce. The inconvenience of traveling longer distances may prevent parents from engaging in these healthy shopping patterns. Consequently, having discordance between neighborhood food quality

perceptions and the perception of places parents actually shop (outside their neighborhood) could adversely affect children's diet quality.

The purpose of the present study was to examine the relationships between parents' perceptions of the food quality at their frequented stores and within their neighborhood, distance to the frequented food stores, and children's diet quality. The first aim was to examine whether parents' ratings of the food quality where they most often purchased groceries were associated with their child's diet quality as measured by their child's overall DASH index score and the F&V component score of DASH. As parents' perceptions and children's diets are jointly influenced by a variety of other factors, parent age, gender, race, ethnicity, and highest level of parental education were included as key covariates. Second, the study aimed to examine whether children who lived closer to the supermarkets and small grocery stores where their parents most often purchased groceries had a better diet quality (e.g. higher overall DASH score and higher F&V component score) than those children who lived farther away from their parents' most frequented store. Finally, this study examined whether parents' perceptions of their most frequented food store differed from their perceptions of their neighborhood food quality and if this discordance in perceptions was related to the distance to their most frequented food store.

## Methods

### *Study Design*

The data were derived from the Neighborhood Impact on Kids (NIK) Study, which employed an observational longitudinal design to collect survey data, anthropometric measurements, and dietary recalls on parent-child pairs. Data for this thesis were drawn from the baseline NIK time point.

### *Study Setting*

NIK was designed to examine whether children from different neighborhoods had different physical activity, eating behaviors, and weight status. The physical activity and nutrition environment (PAE and NE) characteristics of all census block groups (NIK definition of neighborhood) within King County, Washington and San Diego County, California were evaluated based on characteristics thought to support physical activity and healthy eating behaviors.[54, 55] Details on the characteristics used to define neighborhoods based on their physical activity and nutrition environments are provided elsewhere. Briefly, census block groups fell into four possible neighborhood types: high PAE/ low NE, low PAE/ high NE, high on both, or low on both. Evaluations of the PAE were based on the presence or absence of quality parks and the level of expected walkability, whereas the NE evaluations were based on proximity to a supermarket and the density of fast-food restaurants within and surrounding (a .5-mile buffer) the census block group.[54, 55]

### *Study Participants*

Following the neighborhood classification, households with children between the ages of six and 11 were randomly recruited for participation within each neighborhood through publically available phone contact information between September 2007 and January 2009. Of the 8,616

households that were contacted, 7,094 had a working phone number of which 4,975 were screened for interest and eligibility. In total, 944 families were interested and eligible, but only 730 consented to participate in the study. The final sample included 686 parent-child pairs who completed the survey and had valid dietary recall data, representing 572 unique census block groups.

In order to participate in the study, the children had to be between the ages of 6 and 11 at enrollment and have a parent who was also willing to participate. Both the child and the parent had to meet the following eligibility criteria: (1) live in a census block group located within one of the GIS identified neighborhood environment types; (2) be able to exercise at a moderate intensity; (3) not have a health condition associated with obesity or be on a medical treatment that could impact growth.[54] The details of the exclusion criteria related to growth and weight have been described elsewhere.[54] In order to avoid clustering within a household, only one child per household could participate. [54]

The Institutional Review Boards at Seattle Children's Hospital and San Diego State University approved this study.

*Study Measures*

Survey Demographics

Parents completed either a paper or on-line survey about their child and themselves. Items pertaining to the parent and child included gender, race, ethnicity, and age. Parents also answered questions about their own highest level of education and employment status. In addition, parents completed questions regarding the highest education level of adults in the household, motor-vehicle ownership, marital status, and annual household income.

Assessment of the Quality of the Food Environment

Within the survey, parents were also asked to separately rate the quality of the food environment where they commonly purchased groceries and within their neighborhood. Each rating was based on a scale of five statements adapted from a previous survey by Echeverria et al. (2004) that proved to be a reliable measure of neighborhood food quality.[50] Parents reported their degree of agreement with the five statements using a five-item Likert scale that ranged from strongly disagree (worth one point) to strongly agree (worth five points) for both their most frequented food store and the neighborhood food store. The total score for each scale had a possible range from five to 25 points. In order to obtain a continuous score where a higher score indicated increasingly positive views of store or neighborhood food quality, the negatively phrased items in both scales were reverse coded.

The frequented food store quality scale contained the following statements: (1) *Low-fat foods cost too much;* (2) *There is a large selection of fresh fruits and vegetables*; (3) *There is a large selection of low-fat products available*; (4) *The condition of fresh fruits and vegetables is poor*; (5) *Fruits and vegetables cost too much*. The statements for the neighborhood food quality scale included: (1) *There is a large selection of low-fat products available*; (2) *The fresh produce is usually of high quality*; (3) *There is a large selection of fresh fruits and vegetables*; (4) *Fruits and vegetables cost too much*; (5) *Low-fat foods cost too much.* It should be noted that the framing of one item relating to the condition of produce differed between the scales. For the neighborhood scale, the statement was positive, for the food store scale, the statement was negative.

Assessment of Children's Diet Quality

*Dietary Recalls*

Children's dietary intake was assessed with three, random 24-hour dietary recalls that were collected over a two-week period using the 24-hour multiple-pass method. Studies have shown that this is a reliable and valid measure of energy and nutrient intake among young children.[56] Trained research dietitians from the Dietary Data Entry Center at Seattle Children's Hospital used the Nutrition Data System for Research (NDSR) software to collect each child's dietary recall via telephone interview. Children over the age of eight reported for themselves; whereas parents of younger children reported on their child's behalf through the consensus recall approach.

*DASH Index Score*

Following the collection of the dietary recalls, each child's diet profile was analyzed for overall diet quality, as measured by the overall DASH index score. While it is a less common measurement of diet quality, studies have shown that is associated with a healthy diet because participants who followed the DASH eating pattern experienced reduced chronic disease risk.[57-60] Moreover, DASH is one of the healthy eating patterns described in the 2010 Dietary Guidelines for Americans and endorsed by the American Academy of Nutrition and Dietetics.[61] The DASH index score has eight components (grains, vegetables, fruits, dairy, meat, nuts, fats, and sweets) worth ten points each and the standards for achieving the minimum and maximum scores are shown in Table 1. Meeting the standard for the maximum score resulted in full points, whereas meeting the minimum resulted in zero points. Consumption that fell in-between the thresholds received a proportionate score. Consequently, DASH scores had the potential to range from zero to eighty, with higher scores indicating a higher diet quality relative to lower scores.

*Fruit and Vegetable Consumption*

Fruit and vegetable (F&V) consumption was measured with the combined F&V component

scores from the DASH index. These scores could range from zero to twenty. This specific dietary component was an outcome of interest because three of the five items from the perceived neighborhood and frequented food store quality scales addressed perceptions about the quality of produce. In addition, a diet rich in F&V is associated with improved health outcomes. Higher values of DASH F&V component scores indicated higher fruit and vegetable consumption.

Distance

Distance to the most frequented food store was defined as the distance along the street network from the participant's home to the most frequented food store. In the survey, parents could list the names and addresses of up to three stores where they shopped most often for food and rate the frequency of shopping at each of the food stores (*once a month, two to three times a month, once a week, two or three times a week,* or *four or more times a week*). Although parents could list any store type, only stores identified as grocery stores, supermarkets, or market/produce stores were used in the present analysis. Urban Design 4 Health, Inc. (UD4H) geocoded the home-address and the frequented food store address of all parent-child pairs with ArcGIS. UD4H then used ArcGIS to calculate the network distances from home to the most frequented food store. If parents listed two or more stores with equal frequency of use, the distance from home to each store was calculated and then averaged to generate one, overall distance measure.

Discordance

Discordance was defined as the difference in parents' perceptions of the food quality at their frequented stores versus their neighborhood food stores. The frequented food store quality score was subtracted from the neighborhood food quality score. Both the food store quality and neighborhood food quality scores had a possible range of five to 25 points; thus, discordance could range from -20 to 20 points. Negative values indicated better views of the food quality

within parents' frequented food stores relative to the neighborhood. Positive values indicated better views of the neighborhood food quality relative to the parents' frequented food stores. A zero score indicated no difference in parents' perceptions of the food quality within their neighborhood and their frequented food stores.

*Statistical Analyses*

Descriptive statistics were used to examine demographic information, with means and standard deviations for continuous variables and counts and percentages for categorical variables generated overall and by neighborhood type (high or low PAE and NE). Chi-square tests were used to assess significant differences in demographics by neighborhood type for categorical variables, and ANOVAs were used for continuous variables. In order to assess the first aim of the present study, the children's overall DASH scores and F&V component scores were separately regressed against parents' perceptions of the quality of the parents' most frequented food stores using ordinary least squares linear regression with robust standard errors. These models were adjusted for the parent's age, gender, race, ethnicity, as well as the highest education level within the household. In order to address the second aim, the children's overall DASH scores and F&V component scores were separately regressed against the distance from home to the parents' most frequented food store using ordinary least squares linear regression with robust standard errors. In order to meet model assumptions, the distance variable was log-transformed. These models were adjusted for the parent's age, gender, race, ethnicity, as well as the highest education level within the household. The adjusted distance models also included the variable of whether a neighborhood was deemed high or low in physical activity environment (PAE) because participants in the low PAE neighborhoods, based on study design, were less likely to live in a neighborhood with food stores (as the presence or absence of non-residential

destinations was in part how walkability was defined). In order to assess if there was a difference (discordance) between parents' perceptions of neighborhood food quality versus frequented food store quality, a paired t-test was performed. Next, Spearman's rank correlation between the discordance score and log-distance was calculated to assess the strength of the association. Statistical significance was set at the $p<.05$ level. All analyses were performed using STATA software version 12.1 (StataCorp LP, College Station, TX, USA).

## Results

*Descriptive Statistics*

The demographic characteristics of the NIK study participants are shown in Table 2. The children had a mean age of 9.1 years (±1.5 years). Half of the children were female and they were predominantly white (81%); 115 (17%) children identified as Hispanic. The majority (86%) of the parent pairs were mothers who identified as white (89%); 91 (13%) parents also identified as Hispanic. The parent's ages ranged from 26 to 66 years (41.5 ± 5.8 years). In addition, most (93%) parents were married or living with a partner. The income level of the households was high, with nearly half (49%) reporting an annual income above $100,000 and less than 14 percent reporting an income below $50,000. Parents were also highly educated with over 75 percent reporting the highest educated adult in the home attained a college education or higher. In addition, most (99%) participants were from a household that had at least one vehicle.

Table 3 summarizes the children's diet quality scores, parents' perceptions of food quality, as well as shopping frequency and distance to frequented food stores by neighborhood type. Children's overall DASH scores ranged from 19.8 to 61.5 (41.5 ± 7.1) and their F&V component scores ranged from .5 to 20 (9.7± 4.2). There were no indications of significant variation by neighborhood type. Parents' ratings of the food quality where they most frequently shopped were generally positive, 20 out of a possible 25 points (± 3.2), and did not vary significantly by neighborhood type (p=.23). Parents' ratings of the food quality within their neighborhood were also positive: 18.8 out of a possible 25 points (± 3.7). The average distance to the most frequented food store was 2.4 miles, but there was a considerable range (.02-20.5 miles). Those living in the least health promoting neighborhood environment (e.g. low PAE/low NE), traveled significantly greater distances for their food shopping compared with all other neighborhood

types (p<.0001). At the same time, there was no significant variation in shopping frequency by neighborhood type. Two hundred and ninety-two (43%) parents reported shopping at their most frequented store once a week and 288 (42%) reported going to the store two to three times per week or more.

*Parents' Perceptions of Frequented Food Store Quality and Children's Diet Quality*

The linear regression analyses for the influence of parents' perceptions of frequented food store quality on children's diet quality are shown in Table 4. In the unadjusted analyses, children's overall mean DASH scores were significantly, positively related to the parents' perceptions of the quality of the most frequented food store (p=.02, full model $R^2$=.01). The difference in mean DASH scores among two groups of children differing by one point in their parents' ratings of their frequented food store quality was approximately .20 (95% CI: .03, .40). However, after adjusting for parent age, gender, ethnicity, race, and household-level education, the association between parents' perceptions of frequented food store quality and children's overall DASH scores became insignificant (p=.10, full model $R^2$=.05).

Similarly, the mean F&V DASH component score was significantly related to parents' perceptions of the quality of food at their frequented food stores compared to those with negative perceptions (p=.04, full model $R^2$=.01). The difference in mean F&V DASH component score among two groups of children differing by one point in their parents' ratings of their frequented food store quality was approximately .10 (95% CI: .01, .21). After adjusting for parent age, gender, ethnicity, race, and household-level education, the association between parents' perceptions of frequented food store quality and their children's F&V DASH component scores remained significant (p=.05, full model $R^2$=.04).

*Distance to Frequented Food Stores and Children's Diet Quality*

As indicated in Table 5, there was no association between the distance to the most frequently used food stores and children's overall DASH scores in the unadjusted analyses (p=.28, full model $R^2$=.002). In the adjusted model, the association was significant (p=.04, full model $R^2$=.05). It is estimated that the average overall DASH score increases by .26 points for each one-mile increase from the mean distance from home to the most frequented food store (95% CI: .02, .50), adjusting for parent age, gender, ethnicity, race, household-level education, and the neighborhood-based physical activity environment (PAE).

The F&V component scores were also not significant in the unadjusted analyses (p=.25, full model $R^2$=.002). However, in the model adjusted for the parent's age, gender, ethnicity, race, and household-level education, as well as neighborhood-based PAE, the association between the F&V component score and distance was significant (p=.02, full model $R^2$=.05). The analyses indicated that the average F&V component DASH score increases by .18 points for each one-mile increase from the mean distance from home to the most frequented food store (95% CI: .03, .30).

*Discordant Perceptions and Distance to the Most Frequented Food Store*

The paired t-test indicated that parents, on average, held discordant views of the food quality within their neighborhood food stores compared with their most frequented food stores (t= -11.4, p<.0001). On average, parents perceived their neighborhood food stores to be lower in quality than their frequented food store. The items that contributed the most to this difference were: "*There is a large selection of fresh fruits and vegetables"* (t= -9.69, p<.0001) and "*Fruits and vegetables cost too much*" (reverse-coded; t= -11.12, p<.0001), with the most frequented food stores scoring better on these items than the neighborhood food stores.

As shown in Figure 1, the overall results of the Spearman rank correlation indicated a weak

and significant relationship between discordant parental perceptions of neighborhood food quality versus frequented food store quality and log-distance to the most frequented food stores (r=-.1, p=.01). Figure 2 illustrates this relationship by neighborhood-based physical activity environment type (PAE). When stratified by PAE, there was a weak and insignificant association for participants living in high PAE's (r= -.06, p=.28), but a weak and significant association for those living in low PAEs (r= -.14, p=.01). This indicated that the association between the parents' discordant food quality perceptions and the log-distance to the parents' frequented food store was stronger in low PAEs than high PAEs.

## Discussion

This study examined the relationships between parents' perceptions of the food quality at their frequented foods stores and neighborhood food stores, distance to food stores, and children's diet quality.

*Parents' Perceptions of Frequented Food Store Quality and Children's Diet Quality*

Consistent with Veugelers, Sithole, Zhang, and Muhajarine (2008), the present study found a statistically significant positive influence of parents' perceptions of the food quality at their frequented stores on their children's overall diet quality and F&V consumption in the unadjusted analyses; however the association was very small in magnitude.[53] Additionally, these effects were diminished after controlling for the parent's age, gender, ethnicity, race, and household education, which suggests that other factors play important roles in determining children's diet quality. Moreover, household education-level was strongly, positively, and significantly associated with children's overall and F&V component DASH scores in the adjusted models. This finding is consistent with numerous studies that found a positive association between higher parental education level and child diet quality.[62-66] Because education is one of the social determinants of health, higher education levels are linked with greater wealth and better nutrition knowledge, all of which facilitate healthier diet practices relative to those with less knowledge and resources.[67, 68] In addition, parent gender was positively and significantly associated with children's overall DASH scores, whereas parent age was negatively and significantly associated with children's F&V component DASH scores. Mothers may have more of a positive influence on their child's diet than fathers because women tend to do more of the food shopping and preparation than men; thus, mothers' perceptions of food quality are more meaningful. Increasing parent age may have a deleterious effect on children's diet quality because older

parents may be more advanced in their careers, which leaves them tired and wanting to prepare quick meals at home that may not include as many F&V than a parent with more time flexibility.

There are a few possible explanations for why the results failed to be stronger. Many factors at the individual, interpersonal, and societal level influence food purchasing decisions and child dietary quality, including: nutrition knowledge, tastes and preferences, convenience, marketing, price, accessibility, and cultural and social influences.[18, 69-72] Thus, even if parents rated their frequented stores well in terms of the access, pricing, and quality of produce and low-fat foods, they may have still been influenced by unhealthy marketing strategies at these food stores or encountered other influences which diminished any benefit of positive perceptions of the availability of healthful options at their most frequented food store. Another alternative explanation is that the parents' perceptions did not reflect the reality of the food quality at their frequented stores due to social desirability bias. In other words, parents may have over-reported the good aspects of food options at their frequented food stores in order to appear like responsible decision makers with regard to their food shopping habits. Finally, with a predominantly wealthy and well-educated sample, the study sample was biased toward a group that typically has healthy eating patterns, and this lack of variability likely contributed to weak results.

*Distance to Frequented Food Stores and Children's Diet Quality*

Contrary to the hypothesized direction of association, all of the adjusted models indicated that living farther away from the grocery stores and supermarkets most frequented by the parents was related to better children's diet quality. Again, the magnitude of this relationship was very small (e.g. overall DASH and F&V component scores improved by less than one point with each one mile increase from the mean distance). These findings are in agreement with some previous

studies that found a minimally positive impact of increased distance to the supermarket on children's fruit and vegetable consumption.[33, 45] One reason why this might be true is that the most healthy and inexpensive food stores are not located in close proximity to residential areas, which forces parents to travel farther to buy affordable, healthy food.[73] Consequently, a parent's decision to forego shopping at the store close to home in favor of the healthier, distal store becomes a health-promoting choice for their child's diet quality.

There are a few possible explanations for why the results indicated that increased distance benefited children's diet quality. First, the distance measure only captured proximity to food stores with respect to the home address. Consequently, it was unable to account for the complexity of trip behaviors that may have involved other destinations such as work, school, or other community gathering places. Both children and their parents likely spent a good amount of their time outside of the proximal home environment. For example, it may be the case that parents did the majority of their food shopping near to where they worked instead of the home. Thus, the distance from home to the frequented store was not a true reflection of convenience or the time required to shop for groceries. This is consistent with Kerr, Frank, Sallis, Saelens, Glanz, & Chapman's (2012) findings that access to food near the home is less frequent than food access in one's daily activity space and that most food trips start from a non-home location.[73] Additionally, 99 percent of all study participants owned a car, which likely attenuated the challenges of increased distance between the home and the frequented food stores.

*Discordant Views of Neighborhood vs. Frequented Food Store Quality and Distance*

Parents held discordant views of food quality within their neighborhood and frequented food stores, with their frequented food stores receiving more favorable scores. The less favorable neighborhood ratings, suggested that parents traveled outside of their immediate neighborhood in

order to procure healthy, affordable food. The fact that there were no variations in shopping frequency by neighborhood type, despite significant differences in average distance to the most frequented food stores, suggested that parents placed a high value on less expensive, better quality food, and that they were willing to travel beyond their neighborhood offerings to procure that food. The association between discordance and distance may have been stronger in low PAEs versus high PAEs because participants in low PAEs had more limited access to supermarkets. Thus, they were more likely to express negative perceptions about the quality of their local offerings and they were also more likely to travel outside of their neighborhood to access healthy food, than those living in high PAEs without these access barriers.

*Strengths and Limitations*

There were several strengths to the present study. First, the study used a large sample of parent-child pairs from two major metropolitan areas in the U.S.: Seattle, WA and San Diego, CA. Additionally, children completed three random 24-hour dietary recalls, thus the measure of diet quality was likely an accurate reflection of their eating pattern. To our knowledge, this is one the few studies to apply the DASH diet index measure to a youth population.[74]

While this study had numerous strengths, there were also some notable limitations. First, the cross-sectional design made it impossible to infer causality. Second, this study was limited to looking at the influence of generally more healthful food stores (i.e., supermarkets or large grocery stores). By not examining the frequency of use of fast food outlets or other health detracting food resources (e.g. convenience and liquor stores), the positive influence of supermarkets and grocery stores may have been obscured. On a similar note, the survey did not capture how much food was purchased at each store. Consequently, it was impossible to know what quantity of the food consumed by the child and reported in the dietary recalls came from

the stores where the parent reported shopping. Additionally, the sample was predominantly affluent, white, and well-educated, which limits the generalizability of the findings to similar populations. Finally, the NIK study design itself may have also been a limitation. Participants were selected for the study based on the distribution of supportive and unsupportive physical activity and nutritional resources in their neighborhoods, which restricted the variability in neighborhood food availability.

*Implications*

The results of this study indicate that parents' perceptions of the quality of food at their frequented food stores does not have a significant impact on their child's diet quality, as measured by the overall DASH index score or the component F&V DASH score. Thus, while parents' perceptions of food quality of the food stores they frequent may be an important indicator of the health promoting nature of the food environment, they are insufficient in and of themselves to affect their children's diet. The fact that the associations became insignificant in the adjusted models suggests that broader social changes targeting things like inequities in educational attainment continue to be important when it comes to addressing diet quality disparities across different groups. Contrary to our expectations, the children who lived farther from the stores most frequented by their parents had higher diet quality scores compared to those living closer to their frequented store. Therefore, energies directed toward increasing access to supermarkets and grocery stores may be better spent on improving the existing food environment (i.e. changing marketing, pricing, and point of purchase practices), so that it is more supportive of healthy choices.[18, 71] In particular, these findings suggest that parents value affordable, healthy food and that store improvements directed toward increasing access to cheap, healthy food may prove beneficial, especially for those for whom farther travel is unlikely or not feasible (e.g.

those without a car or adequate access to public transit).

*Conclusion*

In contrast with the predicted relationships, the findings of the present study indicated that parents' perceptions of the quality of food at their frequented stores was only weakly associated with their child's diet quality, and shorter distance to these most frequented stores was not highly related to better child's diet quality. This may be due to our incomplete understanding of trip behaviors and the full food environment exposures. Future studies should examine how children's diet quality is related to the food stores within their proximal home environment as well as the food exposures in their own and their parents' daily activity space. The addition of these nuanced interactions may reveal greater information about the relationships between parents' perceptions, food stores, distances traveled to buy food, and children's diet quality, and provide insights about where to intervene for stemming the tide of the childhood obesity epidemic.

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**Table 1. DASH Score: Components and Calorie-Specific Standards for Maximum and Minimum Scores**

| DASH Score Components | Maximum Score | Daily Intake Basis for Maximum Score | | | | Daily Intake Basis for Minimum Score | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1200 Calories | 1400 Calories | 1600 Calories | 1800 Calories | 1200 Calories | 1400 Calories | 1600 Calories | 1800 Calories |
| **Grains** | | | | | | | | | |
| **Total** | 5 | 4 | 5 | 5 | 6 | 0 | 0 | 0 | 0 |
| **Whole (50% of total)** | 5 | 2 | 2.5 | 2.5 | 3 | 0 | 0 | 0 | 0 |
| **Vegetables** | 10 | 2 | 3 | 4 | 4 | 0 | 0 | 0 | 0 |
| **Fruits** | 10 | 3 | 3 | 4 | 4 | 0 | 0 | 0 | 0 |
| **Dairy** | | | | | | | | | |
| **Total** | 5 | 2 | 2 | 3 | 3 | 0 | 0 | 0 | 0 |
| **Low fat (75% of total)** | 5 | 1.5 | 1.5 | 2.25 | 2.25 | 0 | 0 | 0 | 0 |
| **Meat, poultry, fish, eggs** | 10 | 3 | 4 | 5 | 6 | ≥8 | ≥10 | ≥10 | ≥12 |
| **Nuts, seeds, legumes** | 10 | 0.5 | 0.5 | 0.5 | 1 | 0 | 0 | 0 | 0 |
| **Fats, oils** | 10 | 1 | 1 | 2 | 2 | ≥2 | ≥2 | ≥4 | ≥4 |
| **Sweets** | 10 | 0.5 | 0.5 | 0.5 | 1 | ≥1 | ≥1 | ≥1 | ≥2 |

Data are as servings per day unless otherwise noted.

Proportionate scores were assigned to intakes that fell between minimum and maximum levels.

Calorie levels assigned by age and gender: girls 6-8 years = 1200 kcal/day; boys 6-8 years = 1400 kcal/day; girls 9-13 years= 1600 kcal/day; boys 9-13 years= 1800 kcal/day.

Serving recommendations for Maximum Score based on those specified in the DASH Eating Plan at Various Calorie Levels (consistent with the Dietary Guidelines for Americans 2010)[58]; and the American Heart Association's *Dietary Recommendations for Healthy Children*.[75]

Dr. Sarah Couch, Ph.D, RD developed this table.

| Table 2. Participant Demographics [a] | |
|---|---|
| **Characteristic** | **Mean (SD) or Count (%)** |
| **Child Characteristics (N=686)** | |
| ***Age (years)*** | 9.1 (1.5) |
| ***Gender (% female)*** | 343 (50%) |
| ***Ethnicity (% Hispanic)*** | 115 (17%) |
| ***Race*** | |
| *White* | 555 (81%) |
| *African-American* | 20 (3%) |
| *Asian American/ Pacific Islander* | 27 (4%) |
| *Other* | 29 (4%) |
| *More than one* | 55 (8%) |
| **Parent Characteristics (N=686)** | |
| ***Age (years)*** | 41.5 (5.8) |
| ***Gender (% female)*** | 588 (86%) |
| ***Ethnicity (% Hispanic)*** | 91 (13%) |
| ***Race*** | |
| *White* | 598 (89%) |
| *African-American* | 16 (2%) |
| *Asian American/Pacific Islander* | 32 (5%) |
| *Other* | 11 (2%) |
| *More than one* | 16 (2%) |
| **Household Characteristics** | |
| ***Marital Status*** | |
| *Married or living with a partner* | 633 (93%) |
| ***Highest Education Level*** [b] | |
| *Less than college* | 163 (24%) |
| *College* | 267 (39%) |
| *Graduate School* | 250 (37%) |
| ***Annual Income*** | |
| *<$50,000* | 93 (14%) |
| *$50,000-$100,000* | 251 (37%) |
| *>$100,00* | 328 (49%) |
| ***Car Ownership*** | |
| *No vehicle* | 5 (1%) |

a. Data missing on 0-14 participants.
b. Defined by the highest educated adult in the household.

**Table 3. Children's Diet Quality, Parents' Perceptions of Food Quality, Distance to Frequented Food Stores, and Shopping Frequency by Neighborhood Type [a, b]**

| | Low PAE / Low NE N=178 | Low PAE / High NE N=155 | High PAE/ Low NE N=169 | High PAE/ High NE N=184 | p-value |
|---|---|---|---|---|---|
| **Child's diet quality, mean (SD)** | | | | | |
| *Overall DASH score* [c] | 41.2 (7.6) | 41.1 (6.7) | 41.7 (7.2) | 41.9 (6.9) | NS |
| *Fruit & Vegetable DASH component score* [d] | 9.6 (4.2) | 9.2 (4.3) | 10.0 (4.0) | 9.9 (4.2) | NS |
| **Parent perceptions, mean (SD)** | | | | | |
| *Frequented food store quality* [e] | 20.1 (3.3) | 19.7 (3.0) | 19.9 (3.0) | 20.3 (3.2) | NS |
| *Neighborhood food quality* [e] | 18.9 (3.8) | 18.5 (3.4) | 18.8 (3.3) | 18.9 (4.0) | NS |
| *Discordance* [f] | -1.2 (2.7) | -1.1 (2.3) | -1.1 (2.6) | -1.4 (3.3) | NS |
| **Distance to most-frequented food-store (miles), mean (SD)** [g] | 3.3 (2.3) | 2.4 (1.9) | 2.1 (1.6) | 1.9 (2.3) | <.01 |
| **Shopping frequency, N (%)** | | | | | NS |
| *Once/month* | 0 (0%) | 1 (1%) | 2 (1%) | 0 (0%) | |
| *Two-three times/ month* | 29 (16 %) | 21 (14%) | 30 (18%) | 23 (12%) | |
| *Once a week* | 74 (42%) | 59 (38%) | 77 (45%) | 82 (45%) | |
| *Two-three times/week* | 67 (38%) | 58 (37%) | 52 (31%) | 67 (36%) | |
| *Four or more times/week* | 8 (4%) | 16 (10%) | 8 (5%) | 12 (7%) | |

a. The neighborhood type was defined by physical activity environment (PAE) and nutrition environment (NE).
b. Data missing on 0-14 participants.
c. The overall DASH score could range from 0-80 points.
d. The fruit and vegetable component score of DASH could range from 0-20 points.
e. Perceptions were measured with a five-item scale. The sum score could range from 5-25 points. Higher scores indicate more positive perceptions relative to lower scores.
f. Discordance was measured as the difference in parents' perceptions of food quality between their neighborhood food stores and their frequented food stores. Negative scores indicate that parents' perceptions of food quality are worse for the neighborhood relative to the stores where parents shop. Positive scores indicate that parents' perceptions of food quality are better for the neighborhood relative to the stores where parents shop. A score of zero indicates no differences in food quality perceptions between neighborhood food stores and frequented food stores.
g. Measured in miles along the network distance from home to the frequented food store.

**Table 4. Associations Between Children's Overall and Fruit and Vegetable Component DASH Scores and Parents' Perceptions of Frequented Food Store Quality**

| | Overall DASH Score | | Fruit & Vegetable Component DASH Score | |
|---|---|---|---|---|
| | **Model 1: Unadjusted** | **Model 2: Adjusted [a]** | **Model 1: Unadjusted** | **Model 2: Adjusted [a]** |
| **Parents' Perceptions** | 0.20 [b] | 0.15 | 0.10 [b] | 0.10 [b] |
| **Parent Age** | -- | -0.09 | -- | -0.06 [b] |
| **Parent Gender (Female)** | -- | 1.61 [b] | -- | 0.77 |
| **Parent Ethnicity (Hispanic)** | -- | 1.25 | -- | 0.56 |
| **Parent Race [c]** | | | | |
| **African American** | -- | -2.71 | -- | 1.25 |
| **Asian Pacific Islander** | -- | -1.41 | -- | 0.30 |
| **Other** | -- | -3.33 | -- | -0.84 |
| **More than one** | -- | 0.35 | -- | -0.92 |
| **Parent Education [d]** | | | | |
| **Completed College** | -- | 1.10 | -- | 0.90 [b] |
| **Completed Graduate/ Professional Degree** | -- | 2.70 [e] | -- | 1.60 [e] |

a. Adjusted for parent age, gender, ethnicity and race, as well as household-level education, based on a priori assumptions about possible confounders.
b. Significant at the .05 level.
c. Referent group=white.
d. Referent group= less than college.
e. Significant at the .01 level.

Note: Unstandardized regression coefficients are displayed in the table above.

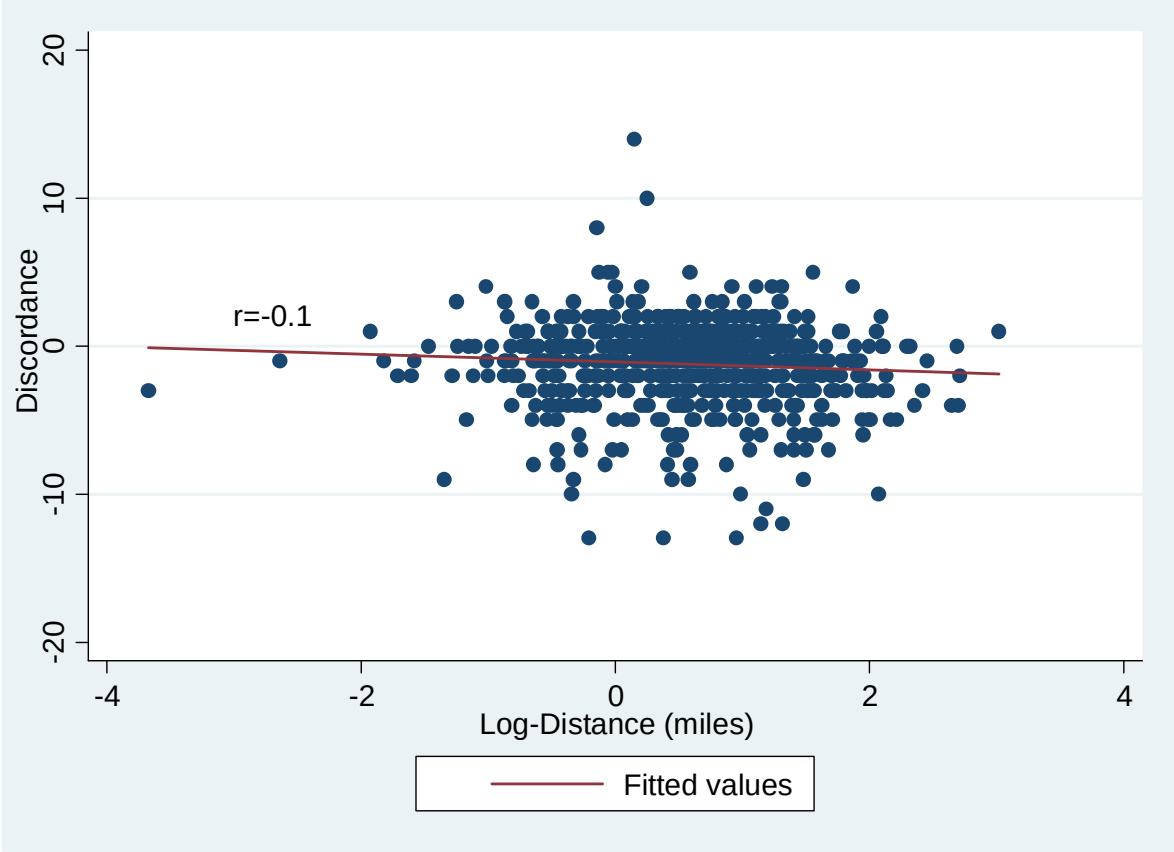
**Table 5. Associations Between Children's Overall and Fruit and Vegetable Component DASH Scores and Log-Distance to the Most Frequented Food Stores**

| | Overall DASH Score | | Fruit & Vegetable Component DASH Score | |
|---|---|---|---|---|
| | **Model 1: Unadjusted** | **Model 2: Adjusted [a]** | **Model 1: Unadjusted** | **Model 2: Adjusted [a]** |
| **Log-Distance** | 0.13 | 0.26 [b] | 0.08 | 0.10 [b] |
| **Parent Age** | -- | -0.80 | -- | -0.05 |
| **Parent Gender (Female)** | -- | 1.67 [b] | -- | 0.80 |
| **Parent Ethnicity (Hispanic)** | -- | 1.23 | -- | 0.47 |
| **Parent Race [c]** | | | | |
| **African American** | -- | -3.01 | -- | 1.05 |
| **Asian Pacific Islander** | -- | -1.93 | | -0.05 |
| **Other** | -- | -3.80 [b] | | -1.20 |
| **More than one** | -- | 0.31 | | -0.94 |
| **Parent Education [d]** | | | | |
| **Completed College** | -- | 1.33 | -- | 1.05 [b] |
| **Completed Graduate/ Professional Degree** | -- | 3.05 [e] | -- | 1.83 [e] |
| **Physical Activity Environment** | -- | 0.71 | -- | 0.60 |

a. Adjusted for parent age, gender, ethnicity and race, as well as household-level education and physical activity environment type, based on a priori assumptions about possible confounders.
b. Significant at the .05 level.
c. Referent group=white.
d. Referent group= less than college.
e. Significant at the .01 level.

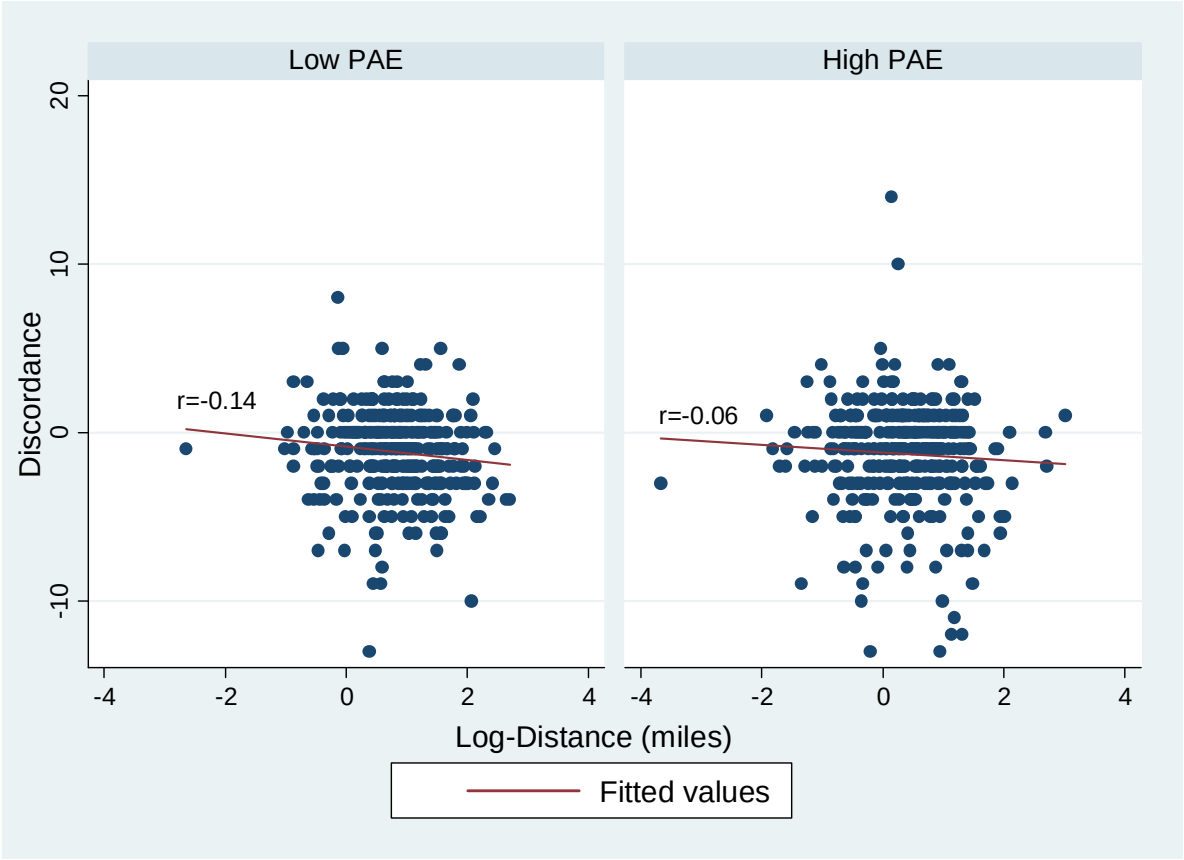
Note: Unstandardized regression coefficients are displayed in the table above.

**Figure 1: Association Between Discordance [a] and Log-Distance from Home to the Most Frequented Food Store**




a. **Discordance** was measured as the difference in parents' perceptions of food quality between their neighborhood food stores and their frequented food stores. Negative scores indicate that parents' perceptions of food quality are worse for the neighborhood relative to the stores where parents shop. Positive scores indicate that parents' perceptions of food quality are better for the neighborhood relative to the stores where parents shop. A score of zero indicates no differences in food quality perceptions between neighborhood food stores and frequented food stores.

**Figure 2: Association Between Discordance [a] and Log-Distance from Home to the Most Frequented Food Store by Physical Activity Environment (PAE) Type**

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